

THE CAMOUFLAGE CRICKET *NEDUBA CARINATA*
WALKER (ORTHOPTERA, TETTIGONIIDÆ)

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One of the first insect songs to attract my attention during my first summer in Oregon was a very rasping rhythmical note with a quality unlike anything I had heard before. It was heard frequently around the forest borders and in brushy places. Several unsuccessful attempts to locate the singer showed me that it was a task requiring more than the usual amount of patience. Finally by lying flat on the ground and creeping cautiously through a thicket of wild rose, I arrived within a few feet of the sound, but still could not see the insect. After watching the surroundings for several minutes a slight movement caught my eye and I saw the noise-maker in plain sight standing among some dead leaves about two feet away. It was a shield-bearer (Decticinæ) so perfectly matched to its surroundings that if I looked away for a moment it was difficult to again locate the insect. The success of its concealment was due largely to the principle used in camouflage during the war, that of breaking up the outline by a patchwork of colors similar to those appearing in the background. For this reason I suggest the name "camouflage cricket" as a common name for this insect which proved to be *Neduba carinata* Walker.

The collecting of specimens in quantity was difficult at first even though the species is quite abundant. The knowledge of what to look for did not help much, for they do not conform to a standard pattern or color. They seem to rely on their invisibility for protection, and resort to jumping only when about to be stepped on. I learned that the best method of collecting them was to move along slowly, probing the dead leaves with my feet until one of the insects was forced to jump. The movement revealed its location and it was then easy to clap a hand over it. Sometimes one of them will jump several times in quick succession. A collector must watch carefully where it stops, for it fades into the background as suddenly as it appears.

COLOR VARIATION

A survey of a large number of specimens of *Neduba carinata* shows a remarkable range of variation in color and pattern. Three general color phases occur—gray, yellowish brown, and reddish brown. Intermediates between any two color phases may also be found, and rare individuals have one color on the sides and another on the dorsal area. The reddish brown and the lighter tones of yellowish brown are duplicated respectively in the dead maple and oak leaves among which the insects frequently occur.

The superimposed fuscous or melanin pattern varies independently of the ground color. Three types of pattern are evident, which may be called, shaded, striped, and mottled. These types are fairly definite although some intergrades occur, and the degree of intensity of the pattern is also variable. There are uniformly colored specimens in various shades of gray, yellowish brown, or reddish brown, depending on the amount of suffused melanin coloring (Fig. N). In some the sides of the body are of a much darker shade than the dorsal area. The striped forms have broad, subdorsal, longitudinal, abdominal stripes of darker color or black, and often narrower stripes, demarking a mid-dorsal pale line. The occiput has two or four longitudinal dark stripes and the pronotal disk may be striped in various ways (Fig. O). The mottled phase has the dark color arranged so as to leave many rounded pale spots of various sizes on nearly all parts of the body including the legs (Fig. P). These forms frequently show the broad, darker subdorsal, abdominal stripes in which the pale spots are usually absent. The mottled phase is the *Neduba carinata picturata* Scudder, which was originally described as a distinct species. Since the mottled pattern occurs in all degrees of intensity and is sometimes blended with the shaded or striped pattern, a variety name for the mottled phase is not warranted.

The only marks that seem to be constant for all specimens are: (1) A pale stripe from the eye to the lateral carinae of pronotum and sometimes extending along the latter as far as the constriction. (2) A dark or black area on the side of the

pronotum leaving a pale area on the ventral edge. (3) A broad dorsal paler area on the abdomen, expanding on the fourth abdominal segment and two and a half to three times as wide on the fifth. This area is bounded by dark stripes in some specimens and is very poorly outlined in others, but can always be detected, at least in fresh specimens.

GEOGRAPHICAL DISTRIBUTION

Caudell¹ gives the range of this species, based on specimens examined, as extending along the Pacific Coast from Wellington, B. C., to Palo Alto and Sierra Madre, California. Buckell² states that it also occurs in the Okanagan Valley in British Columbia. My acquaintance with it is limited largely to western Oregon, where it is widely distributed and quite common. It occurs to some extent in the pine forest on the eastern slope of the Cascades, but probably not in any of the higher portions of the range. Along the upper part of the Rogue River, at an altitude of 2800 feet, it was fairly abundant, but none were found or heard near Crater Lake, altitude 7000 feet.

ECOLOGICAL DISTRIBUTION

In western Oregon the camouflage cricket would be classed as a forest dweller. It is most abundant along the forest borders and in open deciduous woods, and shrub thickets. Even single deciduous trees or clumps of bushes standing a few hundred feet from the forest border may shelter colonies of *Neduba*. In the virgin fir forest it occurs only sparingly in the more open spots. In the Hood River Valley it could be found under oak trees, but not under pure stands of pine.

In general it seems to prefer places where there is sufficient light to promote an abundance of green undergrowth and where the ground is covered with dead deciduous leaves. Even in the pine forest of the eastern slope of the Cascades there are open spots where the deciduous undergrowth or clumps of deciduous trees may supply the favored habitat conditions.

¹ Caudell, A. N. The Decticinæ of North America. Proc. U. S. Nat. Mus. 32:285-410, 1907.

² Buckell, E. R. Proc. Ent. Soc. of B. C. September 1922, No. 20. Systematic series.

HABITS

The song consists of a rhythmical series of from three to thirty or more notes, but most commonly from twelve to twenty. The frequency varies with the temperature in a general way, but there is considerable variation at the same temperature between different individuals, and even in the song of the same individual at different times. At 63 degrees F. the frequency varied between the rates of 130 and 140 per minute. Each note is made by one closing movement of the abbreviated tegmina of the insect.

The notes are in no sense musical, so it would be difficult to ascribe a pitch to them. They resemble the scraping of a file with a piece of steel or the rasping of the teeth of a fine comb. The quality of the sound is different from most of the rasping stridulatory notes of the Orthoptera in that it is essentially a squeaky sound like that produced by flexing two pieces of heavy leather. Caudell has aptly described the sound as "similar to that made by a person gritting the teeth together, but in a higher key." The first note of a series differs from the others by starting with a more pronounced squeak probably made by the initial spreading of the tegmina. To my own imagination the notes seem to repeat the syllables "zwee-wee-wee-wee."

Singing may occur to some extent during the day, but increases toward evening. At night the males become more active and can be approached with less caution. By the light of a pocket flash they can be seen wandering about on the ground and climbing low bushes singing as they go. At times they seem to become very excited and dance with one or both hind legs. They continue their song until after midnight, but in the cool early morning hours before daylight they are usually silent.

The females are much less in evidence at night and are probably feeding or laying eggs. The latter act is accomplished by thrusting the long ovipositor deep into the leaf mold. Apparently the eggs are deposited singly anywhere among the débris covering the ground.

Mating was not observed, but females were found bearing a large spermatophore of the type common among the Tettigoniidæ.

LIFE HISTORY

The young camouflage crickets hatch in early April or possibly in the latter part of March in the vicinity of Corvallis, Oregon. Early in May they reach the third instar, and in June or July they mature.

There are six nymphal instars, which can be distinguished by the length of pronotum and hind femur and, more accurately, by the degree of development of the ovipositor and male genitalia. Minimum and maximum measurements in millimeters for the length of pronotum, hind femur and ovipositor of the various instars are given in the following table:

Instar	1	2	3	4	5	6	Adult
Pronotum	1.2	1.9	2.5	3.6	4.9	7.5	8.7
	1.5	2.2	3.2	4.0	5.5		10.0
Hind femur	3.7	5.3	7.0	9.0	12.0	16.0	18.8
	4.5	6.0	8.8	10.3	13.5		21.5
Ovipositor		.6	1.2	2.0 2.2	4.0 4.5	9.0	16.

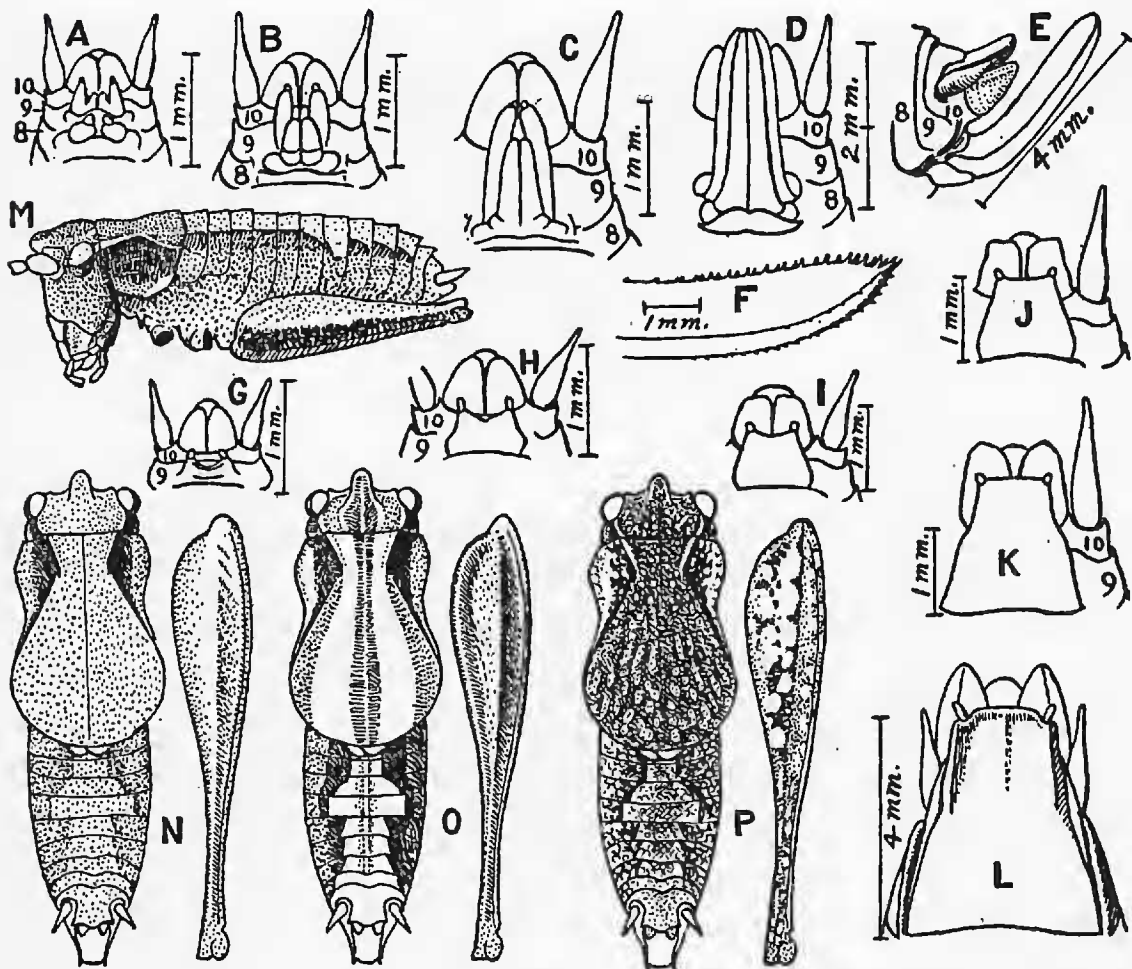
In the first instar the insects conform more closely to a single type of color pattern, as shown in Fig. M. Nearly all have a pale yellow stripe from base of antenna to lateral carina as far as the constriction in the pronotal disk, and including the upper portion of the eye. The second and later instars show all the great range of color variation apparent in the adults.

The sexes can be distinguished in the first instar. The ovipositor originates as a pair of projections on the eighth sternite and two pairs on the ninth sternite (Fig. A). In each succeeding instar they become more elongated, and in the third and later instars the inner projections of the ninth segment are concealed (Fig. B, C, D, E). The ovipositor of the sixth instar is not figured, for it is similar to the fifth but longer and flatter. The teeth of ovipositor do not appear until the adult stage (Fig. F).

The male external genitalia show marked changes only in the subgenital plate which originates as a two-horned projection on the ninth sternite and increases in relative size in suc-

ceeding instars while the horns are reduced to right angles (Fig. G, H, I, J, K, L).

The eggs are elliptical in outline, 4 mm. long and 1.75 mm. wide. They are very turgid and the shell is tough, leathery, and shiny. The color is raw sienna or brown with an olive tinge. Under the low power of a compound microscope the entire surface of the egg is seen to bear minute teeth projecting slightly above the general surface and spaced equidistantly. No definite micropyle can be distinguished, and both ends of the egg are identical in appearance.



Neduba carinata. A, B, C, D, ventral view of tip of abdomen of female nymphal instars 1 to 4, respectively. E, lateral view of tip of abdomen, female instar 5. F, tip of ovipositor of adult or seventh instar. G, H, I, J, K, ventral view of tip of abdomen of male instars 1 to 5, respectively. L, same of adult male. M, markings of first instar. N, dorsal view of body and lateral view of hind femur of shaded form. O, same of striped form. P, same of mottled form.